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Summary

SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

SAN FRANCISCO BAY AREA

Summary

THE BAY AREA SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

SUMMARY REPORT

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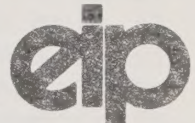
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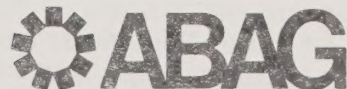
A Report Prepared for the Action Committee for
the Bay Delta Resource Recovery Demonstration
and the Association of Bay Area Governments

December 1973 by

ENVIRONMENTAL IMPACT
PLANNING CORPORATION
SAN FRANCISCO, CALIF.



In association with Frank Stead



ASSOCIATION
OF BAY AREA
GOVERNMENTS

The preparation of this report was financed in part through a Solid Waste Demonstration and Resource Recovery System Grant from the Environmental Protection Agency, under the provisions of Section 204 of the Solid Waste Disposal Act as amended.

December 14, 1973



Environmental Impact
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Mr. Revan A. F. Tranter
Executive Director
Association of Bay Area Governments
Claremont Hotel
Berkeley, California 94705

Paul F. Fritsch, President

Dear Mr. Tranter:

In the fall of 1972 a group of local agencies in the San Francisco Bay Area joined together in an attempt to initiate a Demonstration project to test the feasibility of using composted organic solid wastes in the low-lying islands of the Sacramento-San Joaquin Delta for levee stabilization, land building and agricultural purposes. These local agencies, calling themselves the Bay Delta Resource Recovery Action Committee, also sought to develop the intergovernmental institution necessary to manage this Demonstration project and perhaps to become the regional agency charged with solid waste management. This report documents the efforts of these local entities, acting voluntarily, to attempt to improve the technical and governmental mechanisms operating in the field of solid waste management today.

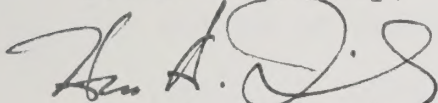
The report is presented in three volumes. Volume 1 describes the preliminary system design for the Demonstration project and looks at the concept of Bay-area wide implementation of the plan. It also details the possible institutional mechanisms necessary to implement the plan. Volume 2 is an environmental evaluation of the Demonstration project and is written in the format of an Environmental Impact Report. Volume 3 contains two technical reports upon which the preliminary system design was based. Part A is a study of the structural characteristics of compost and an evaluation of the feasibility of using compost as a levee strengthening material. This report, prepared by Drs. Duncan and Seed of the Engineering Department of the University of California, Berkeley, represents original research on this subject. Part B documents the preliminary compost experiment conducted by Dr. Samuel Hart at Davis, California, and includes recommended composting specifications for the Demonstration.

The consultants wish to thank the members of the Action Committee and its chairman, Councilman Fred Maggiora, for making this report possible. We would also like to thank the U.S. Army Corps of Engineers (San Francisco and Sacramento Districts), the

Mr. Revan A. F. Tranter
December 14, 1973
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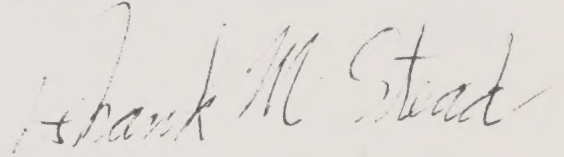
California Department of Water Resources, the Central Valley Regional Water Quality Control Board, and the California Water Resources Control Board for their valuable contributions. Further, we would like to thank the Sierra Club, the League of Women Voters and the San Francisco Planning and Urban Renewal Association, as well as the many public and private organizations and individuals who participated in this study.

Yours very truly,

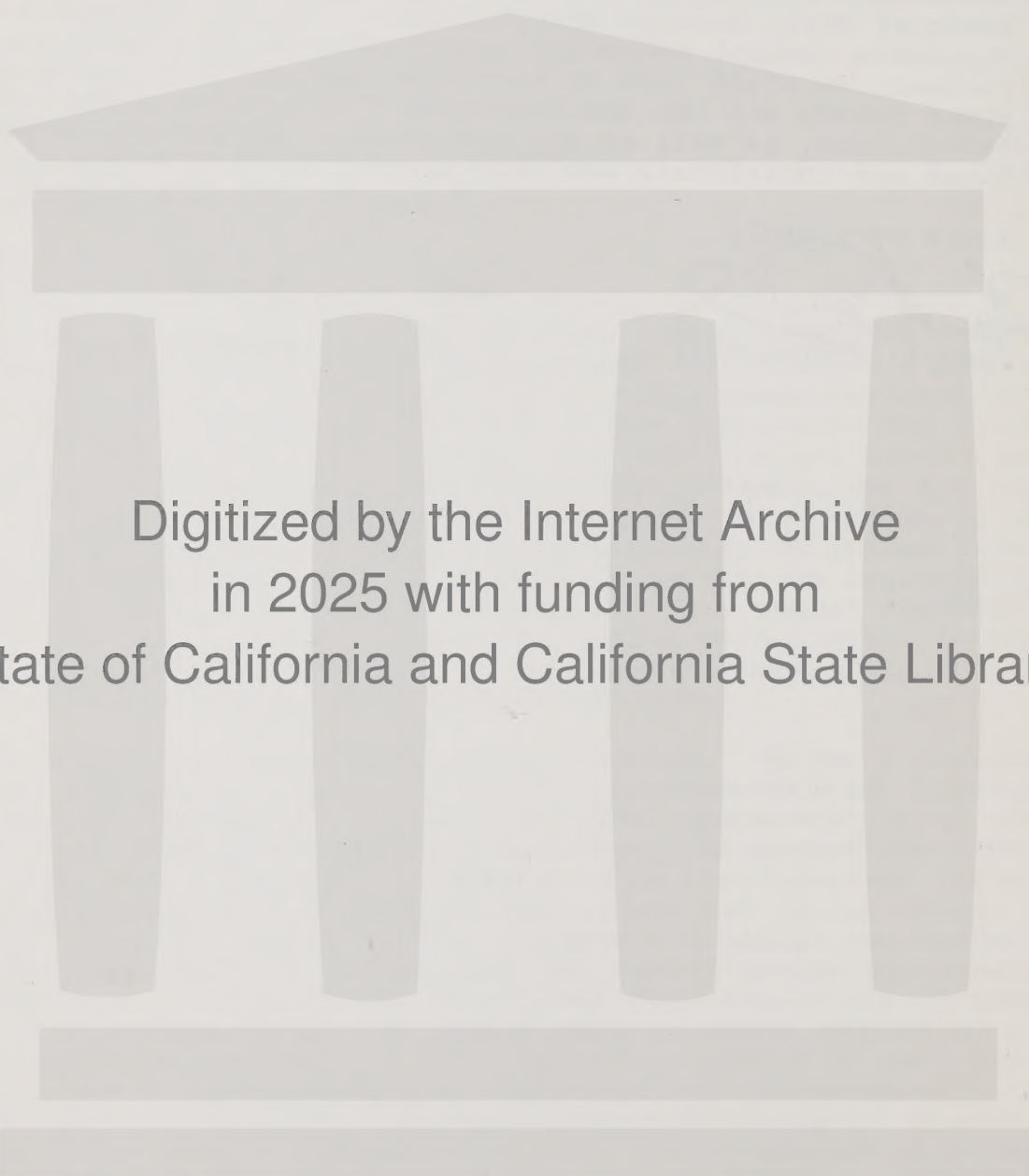


Hans A. Feibusch, P.E.

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Frank M. Stead



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SUMMARY REPORT

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FOREWORD

For over two hundred years this country has operated under a "cowboy economy"--throwing its natural resources away after one-time use. Now, as we consume more and more of these resources we are beginning to see the bottom of the barrel, not only for metals, minerals and wood products, but for fossil fuels as well. So we now find ourselves in danger of running out of both materials of manufacture and construction and sources of fuel. Our response has been to look at solid wastes as a new kind of ore and a new kind of fuel, and this is unquestionably a great step forward.

But at the same time we have been steadily "consuming" our most important resource of all--topsoil--the very basis of the support system for plant and animal life without which man cannot exist. We ship huge crops of vegetable foods and plant-fed animals to cities. Most of these organic materials taken from the soil are never put back. In addition, we allow wind and water to erode away topsoil, we cover it over with highways and cities, and we strip it away to more easily get at large deposits of coal and other mineral resources.

The natural replacement of lost topsoil is amazingly slow. Nature takes from 500 to 1,000 years to make one inch of topsoil. Our deepest concern, therefore, should be to halt, or at least slow down, this steady depletion of the country's soil mantle.

In the Bay Area nearly ten million tons of solid wastes are generated each year. Bay Area wastes that are collected are hauled by truck for burial in soil-covered disposal sites. Some sites are well engineered and operated so as to prevent health hazards, nuisance, and water pollution, but many are not. At the same time, at the north end of San Francisco Bay, where the Sacramento and San Joaquin Rivers merge, a delta of numerous

scattered islands of peat exists. The Delta islands were diked against water intrusion during the early part of the century and include 500,000 acres of intensively cultivated agricultural lands. However, the islands have been sinking at the rate of two to three inches per year and are now ten to fifteen feet below sea level. Many of the dikes are weak and subject to frequent rupture as occurred dramatically in June 1972, when Andrus and Brannan Islands were inundated. If this situation is allowed to continue, loss of most of these valuable agricultural lands is virtually assured.

Several years ago the San Francisco Planning and Urban Renewal Association (SPUR), after a two-year study, proposed a mutual solution to the solid waste and Delta land subsidence problems. A pilot-scale Demonstration project was recommended to test this proposal (The Bay Delta Resource Recovery Demonstration).

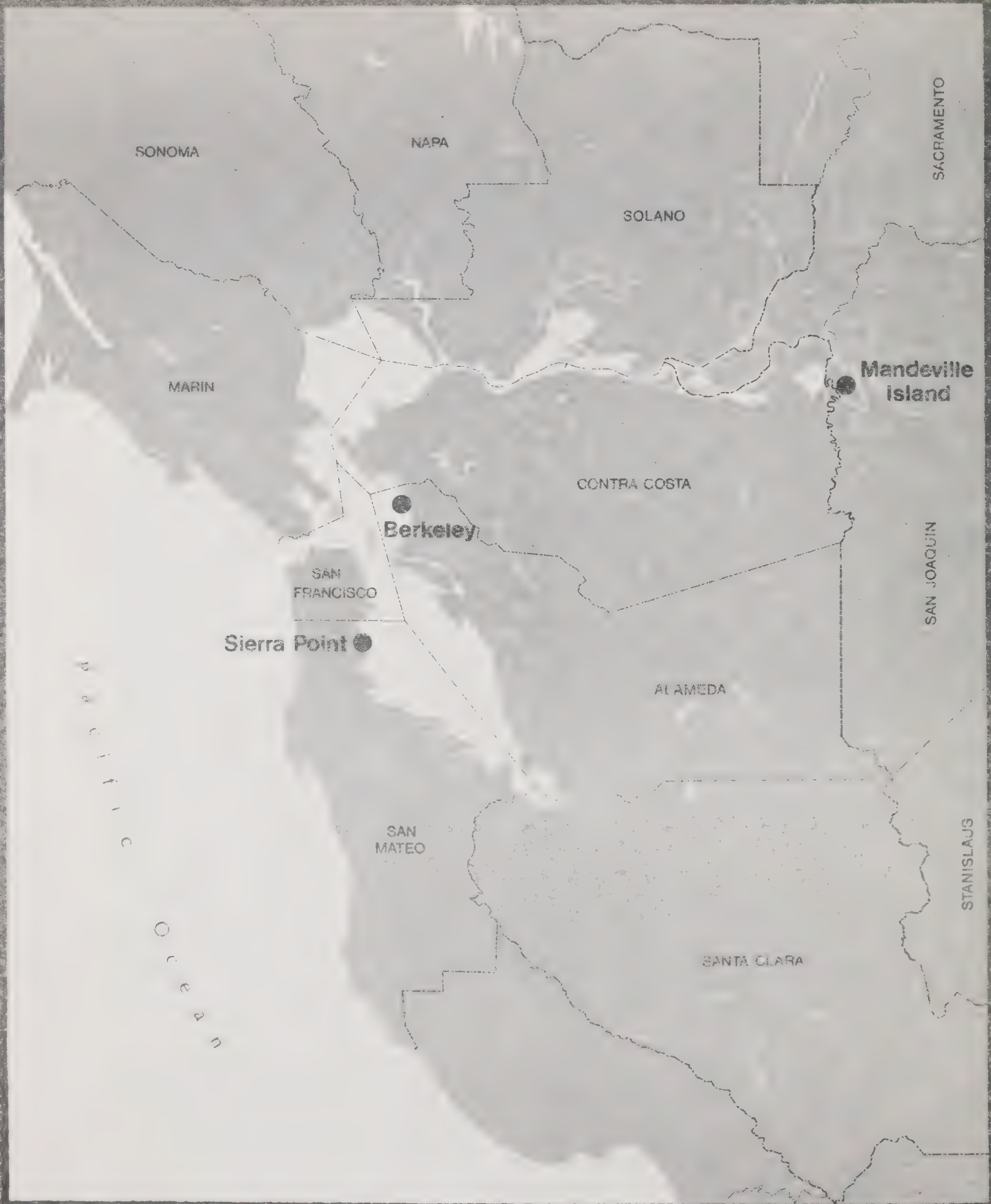
The Demonstration is dedicated to the long range goal of returning to the land the materials from which topsoil is made--namely, the humus produced by bacterial decomposition of plant and animal residues. It would convert the organic portion of municipal refuse into a compost closely resembling natural peat soil. Compared to the conversion of solid wastes into combustible fuel supplies by incineration or pyrolysis, composting is a form of energy recovery occurring in the biological realm. The energy of organic materials in compost supports microbial action which efficiently stores and releases nutrients in the soil.

The peat islands of the Sacramento-San Joaquin Delta were selected as the site for the Demonstration because they illustrate an extreme case of topsoil erosion--caused in this case by the combined effects of wind and auto-oxidation. The islands also afford an unprecedented opportunity to compare directly the fertility of manmade topsoil with highly fertile natural Delta peat.

Because the Delta islands are in imminent danger of extinction by flooding, the first placement of compost will be in the form of a wide berm to physically buttress the levees. Later phases envision application of compost to the entire floors of the islands.

The vast agricultural area of the Delta has the capacity to assimilate the entire output of organic materials from the San Francisco Bay Metropolitan Region on a perpetual basis. Thus, the Bay-Delta Demonstration may well be the harbinger of a truly revolutionary change. We

can perhaps turn from a system which diminishes our natural resources and increases our mountains of waste to a system in which the most valuable resource of all--the land--is preserved in undiminished productivity forever.



Regional Location

Bay Delta Resource Recovery Demonstration Project

eip/ABAG

I. SUMMARY AND CONCLUSIONS

A. INTRODUCTION

This project has as its base the 1971 Report of the San Francisco Planning and Urban Renewal Association entitled "A Solid Wastes Management System for the Bay Region." Commonly known as the Bay Delta Plan, that report called for regional management of solid wastes; a maximum recovery of resources from the solid wastes stream; and a proposal to use the organic portion of municipal refuse for island reclamation in the Sacramento-San Joaquin Delta.

A three-phase program toward regional solid waste management was recommended. In Phase I, the planning would occur for a pilot scale Demonstration to test the concept of separating wastes and transporting the composted organic portion to the Delta islands. An intergovernmental structure would be formed to secure funding for and to manage the Demonstration project. In Phase II the Demonstration would be conducted, and in Phase III the Bay Area could move into permanent, full-scale operation of a regional plan.

Two years of effort by a few dedicated public officials and private citizens resulted in the formation of the Action Committee for the Bay Delta Resource Recovery Demonstration under the sponsorship of the Association of Bay Area Governments (ABAG) to carry out Phase I. The Action Committee developed into a diverse and dynamic coalition of elected officials, public administrators, engineers and concerned citizens representing large and small cities, rural and metropolitan areas, utilities and the private sector of the solid wastes industry.

Although such a broad range of interest often results in cautious progress, it is certainly the most deliberate and responsible way to proceed in planning for any regional solid waste management program.

The planning study focused on three basic areas. First, intergovernmental arrangements were explored to manage the Demonstration project on behalf of the political jurisdictions of the Bay Area. It was thought that these arrangements might serve as a first step to regional cooperation and eventual regional management of solid waste. Second, a preliminary system design was developed for the Demonstration including selection of participants, design of a monitoring program, economic analysis and an environmental evaluation. Finally, the concept of full-scale implementation of the plan in the Bay Area was investigated in terms of its costs and technical, environmental and political feasibility.

The results of this study suggest a number of areas of concern. The formation of an intergovernmental agency to manage the Demonstration has been slow and continued efforts will be required to achieve a final welding of this institution. Feasibility studies indicate that placement of compost behind Delta levees may cause cracking of the levees, and leachates from the compost may have adverse effects on water quality and wildlife in the Delta sloughs. Also, full-scale implementation of the project is likely to result in a high per mile cost of buttressed levee. However, no obstacles have been identified which seem to be insurmountable and it is clear that a pilot scale Demonstration project offers the best opportunity to answer the questions which have been raised. In view of the exciting potential of this program for solving a major portion of the solid waste disposal problem and for contributing to the stabilization of Delta levees, the pilot scale Demonstration should proceed as rapidly as possible in order to test the validity of this plan.

B. REGIONAL SOLID WASTE MANAGEMENT

According to the SPUR report, an essential element of the plan includes the management of solid wastes on a regional basis. Only on a region-wide basis can a resource recovery plants of economical size be developed and efficient transportation routes be established. Perhaps most importantly, only on a regional basis can the intergovernmental agreements be developed which are necessary for large scale land reclamation in the Delta.

A regional waste management plan should be carried out in accordance with the following principles:

- a. A new governmental entity is needed to carry out a region-wide wastes management program for the Bay Area.
- b. To the greatest extent feasible, private enterprise should be encouraged to undertake all aspects of solid wastes management--collection, resource recovery and disposal.
- c. Inventive proposals to carry out aspects of the regional plan should be encouraged, and should be evaluated on the basis of their conformity to the regional plan.

An intergovernmental entity is needed for regional management of solid wastes for the following reasons:

- a. to manage demonstration projects that would have region-wide application;
- b. to solicit and accept funding from state, federal and other sources;
- c. to allocate costs fairly among local jurisdictions;
- d. to plan comprehensively, including transportation and land use as well as waste processing and disposal;
- e. to facilitate inter-county transfers of waste materials;
- f. to make a systems approach to resource recovery more feasible;
- g. and finally, to eliminate the need for direct federal and state controls.

An ultimate regional solid wastes management entity, regardless of its form, should have the following powers and duties:

- a. to arrange for the processing of the region's solid wastes;
- b. to arrange for the building or leasing of a system of regional processing/transfer stations and transport systems;
- c. to set fees sufficient to be self-supporting (which would include the costs of processing and conversion of solid wastes, less income from sales of reclaimed material);
- d. to regulate the selling of all recovered materials on the basis of long-term, competitive bids (recognizing that in some cases private processors will pay for wastes to be recycled, and in other cases the public agency may have to pay them to take the wastes);
- e. to regulate the processing of all toxic and special wastes so as to recover as much reusable material as possible and also to minimize the toxicity of the residues, and then to dispose of such residues in specially approved sites under rigidly enforced conditions to protect public health;
- f. to require that all independent management of wastes (i.e., all wastes not entering the regional management system) meet standards established to protect public health and the environment;
- g. to set standards for the manner in which waste materials are to be delivered to the processing/transfer stations after collection from homes, businesses and factories;
- h. to encourage and support research and demonstration programs designed to process and recover resources from waste materials in the most

efficient manner and at the lowest cost consistent with standards of environmental protection and resource conservation.

Regional management of solid wastes can be implemented by a governmental entity taking any of the following forms:

- a. A multi-purpose, limited function, regional government could be created for the Bay Area and given, as one of its assignments, responsibility for carrying out the wastes management plan.
- b. A single-purpose regional agency (such as the Bay Area Sewer Service Agency) could be created by the California Legislature.
- c. A special wastes management and refuse disposal district encompassing Bay Area counties could be created pursuant to State laws governing either municipal utility or sanitary districts.
- d. A regional agency could be established by existing public bodies pursuant to the State Joint Exercise of Powers Act.

Each of these alternatives has its own advantages and disadvantages and what is likely to develop in the future is difficult to predict. Each of these possibilities and several others were reviewed by the Action Committee in their search for an intergovernmental structure to manage the Demonstration.

C. THE BAY DELTA RESOURCE RECOVERY DEMONSTRATION PROJECT

1. Objectives

A major objective of the Demonstration is to test the feasibility of a regional solid waste management system that would simultaneously recover resources from urban wastes and provide for land reclamation in the Sacramento-San Joaquin Delta. Specific project objectives are:

- a. to demonstrate regional cooperation in conducting a solid waste demonstration project;

- b. to demonstrate the technical and economic feasibility of recovery of resources from solid wastes;
- c. to determine the engineering feasibility of levee reinforcement with composted urban refuse;
- d. to demonstrate the agricultural worth of new soil built from composted refuse;
- e. to determine the environmental effects, especially on air and water, of placing compost on a Delta island.

2. Operational Description

The Demonstration would be conducted over a two-year period, processing municipal refuse and sewage sludge in Berkeley and San Francisco.

In Berkeley, 200 tons per day of municipal refuse would be delivered to a transfer station for shredding, air classification and magnetic separation of ferrous metals. The light organic fraction would then be transported to a composting site located at the Berkeley landfill. Partially dewatered, digested sewage sludge from the East Bay Municipal Utility District would be mixed with the refuse in a windrow composting operation.

In San Francisco, residential refuse delivered to the existing transfer station would be shredded and air classified for recovery of metals and possibly glass; 150 tons per day of the light organic fraction of this refuse would be delivered to a composting site on land owned by the Sanitary Fill Company at Sierra Point in South San Francisco. Digested sewage sludge would be delivered to the composting plant from San Francisco's Southeast Sewage Treatment plant.

At each site, composting would be accomplished in long windrows or piles which are turned, aerated and moistened every few days to maintain aerobic (presence of oxygen) conditions. Composting would occur for approximately 21 days. The material would then be screened to remove plastic film and oversize particles.



Aerial view of the Bay-Delta Area
with Sierra Point, Berkeley, and
Mandeville Island indicated.

Pacific Resources, Inc.



Bay Delta Resource Recovery Demonstration Project





The Berkeley waterfront in 1971
with proposed composting site in foreground.

Pacific Resources, Inc.



Bay Delta Resource Recovery Demonstration Project





The Berkeley composting site - Albany Hill and Berkeley hills in background.



Bay Delta Resource Recovery Demonstration Project





View of waterway adjacent to Sierra Point.



The Sierra Point composting site.

About 100 tons of compost per day would be produced at each site for a total of 1,000 tons per week.

At each site, the compost would be loaded onto a barge docked in the adjacent waterway and shipped at weekly intervals to Mandeville Island in the Sacramento-San Joaquin Delta. The barges would be unloaded by a crane and compost would be placed behind an 1,800 foot stretch of levee in a berm extending up to 500 feet inland. This berm would be built up slowly over a two-year period to prevent excessive compression of the peat resulting from high loading rates that might weaken the levee. Monitoring of air quality, water quality, soil stability, agricultural productivity and biotic effects would be conducted to determine if large scale application of compost could be accomplished without environmental impairment to the Delta. Knowledge would also be gained about the extent of composting required, materials handling techniques and levee reinforcement procedures that could be applied to a full-scale operation.

3. Governmental Structure

The Demonstration project would be managed by an inter-governmental structure representing jurisdictions of the Bay Delta area.

For the purposes of the Demonstration, only a few of the functions of a regional solid waste management entity described in Section B need be served by the selected intergovernmental structure. These include:

- a. the ability to manage the Demonstration project;
- b. the ability to solicit and accept funding from state and federal sources;
- c. the ability to fairly allocate the regional share of costs over local jurisdictions.

Several intergovernmental structures emerge as possible forms to manage the Bay Delta Resource Recovery Demonstration Project. The first involves the establishment of a Joint Exercise of Powers Agency consisting

of all the counties of the Bay Delta region. The directors of the Agency could be elected officials of the constituent units, or they could be persons chosen by these units of government, either laymen or local officials such as public works directors. The second possibility is that Association of Bay Area Governments (ABAG) expand its traditional role of advisory planning to assume stewardship of the Demonstration project. The third is that a Joint Exercise of Powers Agency be formed among Bay Delta counties which would contract with ABAG for administrative services. And finally, a memorandum of agreement between ABAG and the Sacramento and San Joaquin Councils of Government could be formed.

Each of these alternatives would satisfy the requirements of the Demonstration and is suitable for transformation into the solid waste management arm of a possible future regional organization.

As of the date of this report the Action Committee has reconstituted itself as a Joint Powers Agency to pursue funding for the Demonstration. However, this Agency is only an interim agreement until an agency to manage the Demonstration can be established. The formation of this latter agency will require continued efforts by the new Joint Powers Agency in the months ahead.

4. Economic Analysis and Proposed Funding

The estimated cost of conducting the Demonstration is \$6.9 million as shown in the table on the following page:

	(A) Capital Costs	(B) Annual Operating Costs	(C) = (A) + 2 (B) Total Cost
Processing/Transfer Station	253,000	162,000	577,000
Composting	2,250,000	692,000	3,634,000
Barge transport	500,000	545,000	1,590,000
Compost placement	110,000	200,000	510,000
Monitoring	54,000	170,000	394,000
Project supervision		50,000	100,000
Other	25,000	25,000	75,000
Total	\$3,192,000	\$1,844,000	\$6,880,000

As the benefits of the Demonstration accrue to regional, state and federal interests, it is proposed that funding be divided among these levels of government. The recommended percentage cost allocation is 10% regional, 40% state and 50% federal. (The rationale for this allocation is contained in Section IIIC.) It is recommended that the regional share be divided among all counties of the Bay Area on a pro rata population basis.

D. CONCEPT OF A FULL-SCALE SYSTEM

1. Transfer Stations and Resource Recovery

As public sentiment for resource recovery continues to mount, and as close in landfill sites around the perimeter of San Francisco Bay become unavailable for further dumping operations, more and more communities will need to develop transfer stations regardless of the ultimate disposition of the waste. The transfer station owned by the San Francisco scavenger companies is a prototype of this operation. Once the need for a transfer station is established, it is increasingly apparent that the recovery of metals and glass through shredding and

mechanical separation is technically feasible and probably economically viable, given a sufficient quantity of refuse. A multitude of resource recovery systems adapted from mining and lumbering industries are currently under development or installation across the United States. Most of these systems are based on the principal of particle size reduction followed by ballistic separation of the light organic fraction of solid wastes from the heavy, largely inert fraction. Over the next decade it is likely that such systems will be installed within the Bay Area. The SPUR report projected a need for 16 such transfer stations although the exact number and location of these stations will depend upon many factors. The extent of resource recovery at these stations will depend more upon the market price for reclaimed materials than on the availability of the technology needed to produce them.

2. Composting

Composting technology has been extensively developed in both Europe and the United States. Many composting processes are available, ranging from enclosed digesters with automatic control of such factors as moisture and aeration, to windrow systems where organic wastes are piled in long rows and turned every few days by specially designed vehicles. An enclosed composting system will soon be demonstrated by the Delaware Reclamation Project in Wilmington, Delaware under an EPA grant. Enclosed systems may be impractical for the composting of 5-10,000 tons per day of organic wastes in the Bay Area. The largest systems which have been designed to date have a capacity of only 200-300 tons per day. Windrow composting was selected in the preliminary design for the Demonstration because it appears more feasible to scale up. The only limit to its capacity is the availability of land--a total of perhaps 300 acres would be needed to compost all the Bay Area's wastes. This could be accomplished on completed landfills or on marginal lands around the Bay Area. A key aim of the Demonstration is to determine the optimal composting process that would apply on a large scale.

Over the last 20 years American composting operations have largely been unsuccessful, not due to technological problems, but because of a lack of market for sale of

the humus product. In contrast, the Bay-Delta plan has an automatic function for humus in the Delta. Its use would serve the general interest and would be supported by public payment if its value for levee stabilization and topsoil building can be demonstrated.

3. Transportation

Finished compost would be delivered to most islands in the Delta by barge. One thousand- and two thousand-ton capacity barges can be designed with special screw conveyors and elevators for efficient unloading at the destination island. The unloading operation could occur at a single point on an island or, conceivably, the barge could unload at various points around the island as sections of the levee berm were completed. A few islands in the Delta can also be reached by rail. The feasibility of rail haul would depend on locating the composting site near a rail line.

4. Levee Reinforcement

Studies conducted by Duncan and Seed¹ on the feasibility of stabilizing Delta levees with a compost berm indicate that both beneficial and detrimental effects could result. While it would provide increased stability on the land-side slope of the levee, non-uniform settlement of the underlying peat could result in longitudinal cracking of the levee over a period of years. Settlement would also result in lowering the elevation of the levee tops causing some loss of "freeboard." Considering the need to eventually strengthen the levees by some means, the report concludes that constructing a berm adjacent to the levees appears to be the best method of strengthening them, and that compost has engineering properties suited for this task. The conclusions reached are based on a preliminary study and only carefully conducted field studies can provide definitive information on the suitability of compost as a levee strengthening material.

¹See Volume 3, Technical Report on Levee Stabilization and Composting.

5. Impact on Solid Waste Disposal

Full-scale operation of the plan could have a major impact on the quantity of solid wastes requiring disposal in the Bay Area. Solid wastes reaching disposal sites can be classified as follows:

<u>Category</u>	<u>% of Total Disposal</u>
Residential	35.7%
Commercial and public (including sewage sludge)	42.9
Construction and demolition	14.3
Industrial	<u>7.1</u>
	100.0%

If newspapers are sorted for recycling and residential and commercial wastes are processed for recovery of metals and glass and composting of the organic remainder, the estimated disposition of all wastes is as follows:

<u>Item</u>	<u>% of Total Wastes</u>
Compost (35% moisture)	40.0%
Recovered metals, glass and paper	10.0
Carbon dioxide and water lost	20.0
Residue for disposal	<u>30.0</u>
	100.0%

It is likely that not all commercial wastes are suitable for composting which would increase the amount of wastes requiring disposal. On the other hand, if residuals (plastics, rubber, leather and other combustibles) can be used for energy production or if construction debris can find a useful application, less wastes would require disposal. Thus, as a first approximation it appears that between 50% and 70% of the total solid waste disposal load of the Bay Area could be managed through resource recovery and composting for land reclamation. Because sewage sludge is generated relative to organic refuse in a proportion

optimal for proper composting, all sewage sludge could be recycled in the process.

6. Impact on Levee Stabilization

Each year the repair of breeched levees becomes more problematical. Unless a permanent levee protection plan is soon developed, other islands may flood as have Frank's Tract, Big Break and the west end of Sherman Island, with irreparable loss of agricultural land and human settlements.

The quantity of solid wastes available in the Bay Area for conversion into levee reinforcing material appears to be sufficient to treat unstable levees at a moderate rate. According to the most recent figures from the State Department of Health, 5.7 million tons of solid wastes are disposed of in the Bay Delta Area annually. Of this total, it is estimated that 2.25 million tons of compost could be produced per year, enough to reinforce 5.5 miles of levee. This quantity of compost will increase, however, since annual solid waste generation is likely to keep growing and since agricultural wastes, which would roughly double the available supply of organic materials for composting may require disposal in the future.

About 200 miles of levee have been identified by the Corps of Engineers as being in some state of deterioration. At a rate of 5.5 miles of levee per year, about 36 years would be required to stabilize these levees. It would of course be prudent to begin with levees which are in the worst condition, and then proceed to those which are in less immediate need of care.

7. Environmental Effects

The Bay Delta plan offers an opportunity to alleviate adverse environmental effects resulting from both solid waste disposal operations and the subsidence of land in the Sacramento-San Joaquin Delta.

Solid wastes, including sewage sludge are in most cases unprocessed and dumped in landfills around the perimeter of the Bay. This results in a loss of recoverable resources and often a removal of wildlife habitat

and impairment to the quality of waters surrounding the disposal site. The Bay Delta plan would at least cut in half the volume of wastes requiring conventional landfill.

In the Delta, the plan would offer an opportunity to strengthen weak sections of the levee, provide additional top soil for agriculture, and possibly reduce the amount of airborne peat dust. By preserving Delta levees, vast areas of highly valuable agricultural land would be protected, as well as the quality of Delta waters by avoiding the serious salt water intrusion from San Francisco which occurs when levees are breached.

The potential exists for environmental impairment, however. Thus a major reason for conducting the Demonstration is to monitor air quality, water quality, levee performance, agricultural productivity and biotic impacts.

In an environmental evaluation conducted for the Demonstration, several potential problems were identified. The most significant was the possible leaching of contaminants into Delta waters resulting in adverse impacts on wildlife and water quality. Although it may develop that some restrictions need to be placed on the kinds of refuse and sludge used, no findings have been uncovered indicating that unacceptable environmental impacts would occur. The ultimate environmental safeguard of the plan is that adverse environmental effects can be detected in the pilot-scale Demonstration before full-scale implementation ever occurs.

8. Projected Costs

A basic assumption underlying the Bay-Delta plan is that in the future, municipalities will be responsible for the conversion of solid wastes into useful and marketable products and for the disposal of the remaining residue. A higher level jurisdiction, representing the broader public interest at the state and/or federal level would be responsible for the transportation and placement of compost in the Delta. Such an approach will be needed to achieve a fair division of economic responsibility among the parties that would benefit from this double-goaled program.

The local share of full-scale operation of the Bay Delta plan could range from \$9-\$12 per ton of refuse processed. This is considerably higher than the cost of local landfill operations which cost about \$2-\$4 per ton. However, estimates for the cost of regional sanitary landfills (requiring baling and long transportation hauls) have been offered from \$7-\$15 per ton. Thus, as close-in landfill sites become unavailable and as disposal operations are upgraded to true sanitary landfill requirements, it appears that the Bay-Delta plan could be an economically viable alternative to municipalities seeking new solutions to the solid waste management problem.

The Bay-Delta plan also involves the expense of transporting compost to the Delta and placement of the material behind levees. Preliminary estimates indicate that this could cost on the order of \$7 per ton of compost applied. Assuming that 75 tons of compost would be needed per foot of levee treated, this cost is estimated to be \$2.8 million per mile of levee treated. Using all of the organic wastes of the Bay Delta Area would result in the buttressing of at least 5.5 miles of levee annually at a cost of about \$15 million.

These costs are estimated conservatively and they are based upon many assumptions whose validity cannot be determined until more conclusive results are obtained from the Demonstration. Even if these costs prevail, less expensive alternative proposals for buttressing levees with dredger spoils may prove infeasible for a variety of reasons. Dredger spoils are almost twice as dense as compacted compost and their weight may cause even greater cracking and settlement of levees than predicted for compost. Also, dredger spoils may not be obtainable from adjacent river channels due to permit restrictions. Barge haul from remote sources would increase costs considerably and may offer only random availability. In contrast, organic solid wastes are generated on a constant, predictable basis and would offer a permanent, dependable supply.

9. Political Feasibility

The major test of the viability of the Bay-Delta plan will probably not reside in its economic, environmental

or technical feasibility, but in its political feasibility. Nearly unprecedented cooperation between local governments, Delta landowners, the refuse removal industry, and state and federal agencies must be achieved in order to make a sufficient quantity of compost available for preservation of the Sacramento-San Joaquin Delta. This political cooperation will ultimately be the essential ingredient required to convert an exciting idea with tremendous potential into an operating reality.

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